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TEMPORAL VARIATION OF METEOROLOGICAL DROUGHT IN MEWAR REGION OF RAJASTHAN

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ABSTRACT

The study investigated the temporal change of meteorological drought in the Mewar region with the help of Standardized Precipitation Index (SPI). Total area of Mewar region was divided into 56 grids of 30 × 30 km. Monthly rainfall (1981-2014) of 17 stations was interpolated using Inverse Distance weighing method of ArcGIS 9.3 and gridded monthly rainfall was generated. Mean monthly areal precipitation in Mewar region was calculated by averaging rainfall of each grid to determine the regional representative of the Standardized Precipitation Index at various time scales (Ex., 6-, 9-, 12 and 24- month SPI) for examining the regional nature of drought attribute like severity, magnitude and intensity. The study found out many moderate, severe and extreme drought events during the period of analysis. The results of the study can be used for formulating a drought plan and mitigation strategies for the region.

KEYWORDS: Temporal Variation, Mewar Region & Standardized Precipitation Index

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Original Article

INTRODUCTION

Drought is the world's most expensive natural disaster. Globally, it causes loss of between 6-8 billion USD every year and affects more people than any other form of natural catastrophe (Keyantash and Dracup, 2002). There are various methods that have been explored in the past for assessment of drought, such as measuring of lack of rainfall, shortage of streamflow, reduced levels of water storage and drought indices. Drought Indices are effective during decision making (Hayes, 2003) in the events such as to initiate drought relief programs, to measure the deficits of water in water resources, to assess drought severity, etc. So drought indices are widely used for drought assessment (Heim, 2002; Keyantash and Dracup, 2002; Smakhtin and Hughes, 2004 and married *et al.*, 2006). Meteorological drought indices such as SPI, PDSI and CMI are widely used for drought monitoring (Kumar *et al.*, 2012 and Patel *et al.*, 2012). Rajasthan is the largest State of India, which contributes an area of 10.4% and population of 5% of the country's total (SAARC Disaster Management Center New Delhi, 2008). The average rainfall of Rajasthan is 57.43 cm (2001) in the state and it varies significantly across different region. The state has only 1% of India's water resources (GOI, 2004). In the history of Rajasthan, there have been 48 drought years of different intensity from 1901 (last 102 years). A more detailed study revealed that districts in Rajasthan which were not affected by droughts in 102 years is only in 9. Out of 13 states frequently announced as drought-prone, Rajasthan is the most vulnerable state in the country with the highest chance of drought incidences (Rathore, 2005).

METHODOLOGY

Study Area

The present study investigates the drought in the Mewar region of Rajasthan. The region situated between 72^0 59' 32'' E to 75^0 49' 21'' E longitude of 23^0 47' 55'' N to 25^0 57' 58'' N latitude and encompasses, broadly the districts of Rajsamand, Udaipur, Chittorgarh and Bhilwara (Figure 1) (Rathore, 2011). Average annual rainfall of the region is 660 mm/year (Rathore, 2010). This region suffered with severe droughts at many times in the past and also many parts of the area suffer from frequent droughts stressing water supply systems and the community that depends on them.

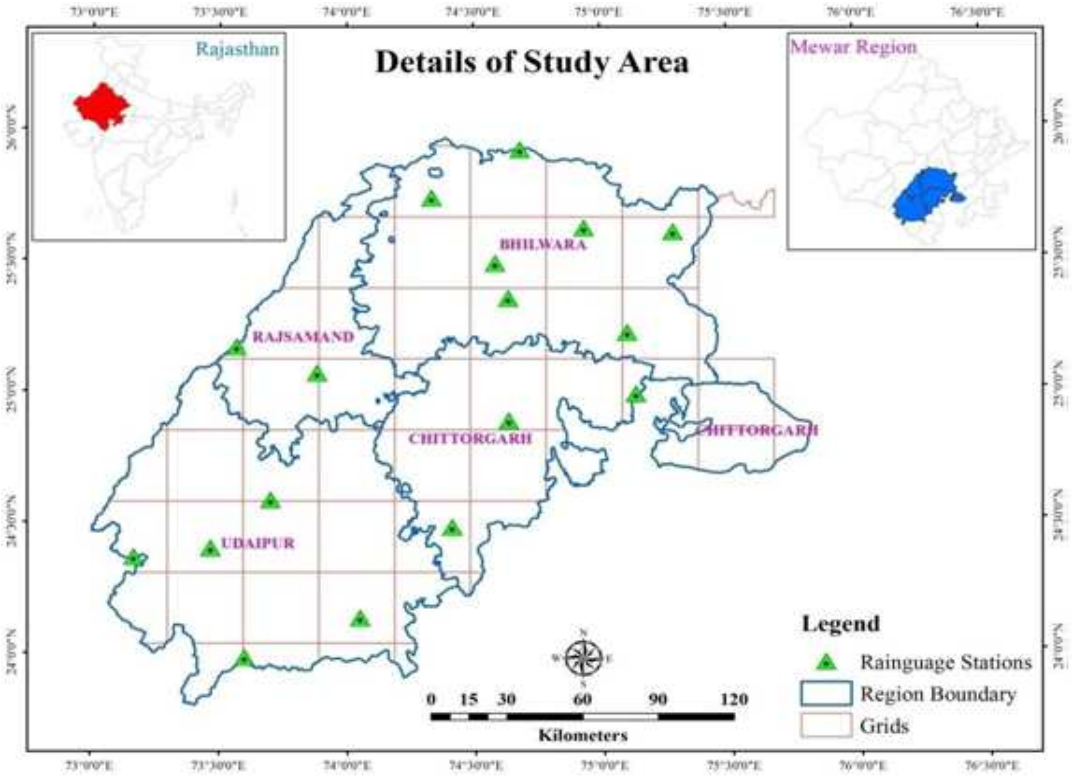

Figure 1: Details of the Study Area

Data Used

The investigation used the rainfall as a meteorological drought indicator. The monthly rainfall data from 1981-2014 measured at 17 rain gauge stations in the Mewar region was collected from Water Resource Department, Rajasthan. Details of rain gauge stations along with their geographic location are shown in Figure 1. IDW approach is used for interpolation of rainfall (Mishra and Desai, 2005). Total area of Mewar region was divided into 56 grids of 30 × 30 km. Monthly rainfall was interpolated by IDW approach (ArcGIS 9.3) and monthly rainfall from each grid was created. Mean monthly regional rainfall was calculated by averaging gridded rainfall to develop Standard Precipitation Index at various time scales (Ex., 6-, 9-, 12 and 24- month SPI) for assessing the regional behavior of drought characteristics. World Meteorological Organization recommended SPI as a standard to analyze meteorological droughts (Dutra *et al*., 2013). Mishra and Desai, 2005 explained the procedure for the computation of SPI in detail. SPI program, SPI_SL_6, developed by the National Drought Mitigation Centre (University of Nebraska-Lincoln, was used to compute the time series of Standard Precipitation Index.

RESULTS AND DISCUSSIONS

The SPI was used to provide an indicator of drought severity. The temporal characteristics of droughts in Mewar region were analyzed, based on the regional representation of SPI value, to assess the regional droughts. Regional representative of monthly SPI values has been computed, for the Mewar region at multiple time scales (6, 9, 12 and 24 months), using mean monthly areal rainfall. Different time scales of SPI help to find out different types of droughts in the region. A 6-month SPI is very effective in showing the rainfall, over different seasons.6-month and 9-month SPI are associated with streamflows and reservoir levels (http://www.in.gov/dnr/water/4864.htm). SPI values at SPI 12 and SPI 24 time scales are representatives of long term drought in this study because; these indices were developed over longer time scales. In these long term precipitation indices hydrologic drought conditions, such as groundwater level, lake water capacity and streamflow, and reservoir storage are reflected (Belayneh, 2012).

The 6-, 9-, 12- and 24-month SPI values for Mewar region is shown in Figure 2-5, for the year 1981-2014. As shown in Fig. 2-5, characteristics of drought change with time. Droughts become less frequent at longer time scales, but their duration increases (Saravi *et al.*, 2009). The monthly SPI series showed that, the region experienced droughts frequently in the period of drought analysis, and detected several severe and extreme drought events at multiple time scales.

The region had experienced droughts of varying severity and duration at 6-month time scale (Figure 2). The Mewar region faced twelve extreme droughts between 1986-2002, between the period of 1981-1985, followed by 2003-2014 moderate to severe droughts, frequently occurred in the region. Even though the year 1987 had the longest drought in the study period, the peak magnitude (-17.35) and peak intensity was more for the year 2002.

May 1987, July 2002 and December 2002 in 9-month time scale (Figure 3) found as more intense droughts in the Mewar region. About 55 % of the years in the study period were under moderate, sever and extreme conditions, the rest of the year exhibited near normal condition. Year 2002 (-16.93), 1987 (-15.42) and 2000 (-12.04) were found as years with high magnitude. 2002 and 1987 had 8 months and 12 months under drought condition, but the mean intensity (-2.11) of SPI was high for 2002 and found year was found chronic.

At 12-month time scale (Figure 4) drought events occurred between periods of 1987-1990 and 1999-2003. 2002, 1988 and 2000 had a peak magnitude of -14.31.-13.92 and -13.42 had a devastating effect in the region. The Mewar region faced drought in 24-month timescale (Figure 5) between 1981-1982, 1988-1990 and 1998-2005 which had a great negative impact on surface and ground water resources in the region. Year 1988 had a peak magnitude of -17.88 followed by 2003 (-15.08) and 2000 (-14.87).

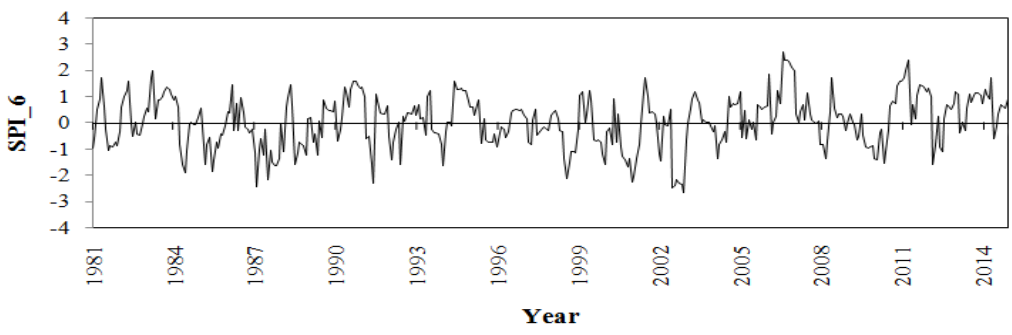

Figure 2: Time Series of SPI Values at 6-Month Time Scale for Mewar Region

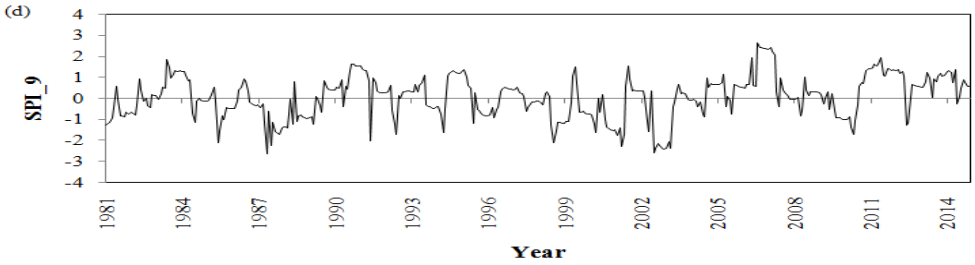

Figure 3: Time Series of SPI Values at 9-Month Time Scale for Mewar Region

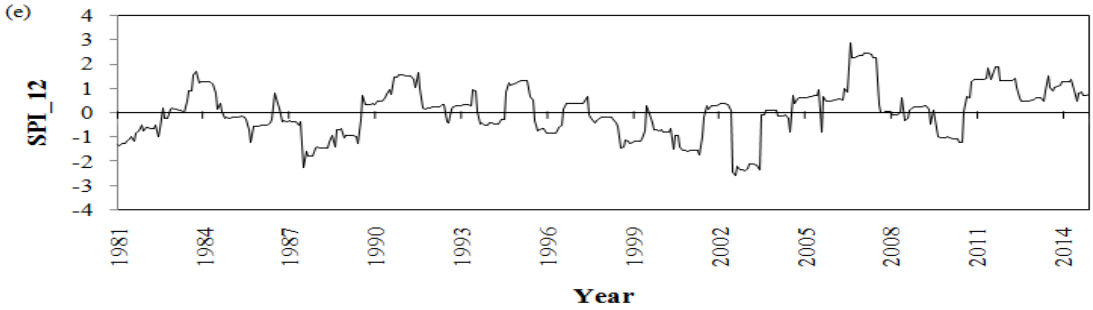

Figure 4: Time Series of SPI Values at 12-Month Time Scale for Mewar Region

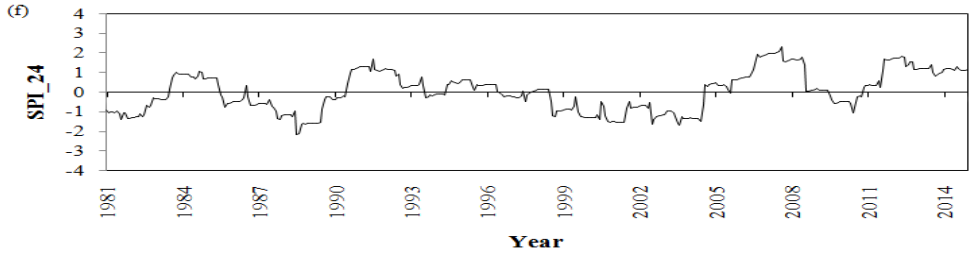

Figure 5: Time Series of SPI Values at 24-Month Time Scale for Mewar Region

CONCLUSIONS

The time series of SPI indicated that the region experienced frequent droughts in the period of drought analysis (1981-21014) and detected several severe and extreme drought events at various time scales. The results of the study can used for formulating a drought plan and mitigation strategies for the region by water resource managers.

REFERENCES

1. *Belayneh, A. (2012). Short term and long term SPI drought forecasts using wavelet neural networks and wavelet support vector regression in the Awash River Basin of Ethiopia. Thesis submitted to Department of Bioresource Engineering, MacDonald Campus of McGill University. Canada.*
2. *Dutra, E., Giuseppe, F. Di., Wetterhall, F. and Pappenberger, F. (2013). Seasonal forecasts of droughts in African basins using the Standardized Precipitation Index. Hydrol. Earth Syst. Sci.**17**:2359–2373.*
3. *GoI. (2004). Drought–2002. New Delhi: Department of Agriculture and Cooperation, Ministry of Agriculture.*
4. *Hayes, M. J. (2003). Drought Indices. National Drought Mitigation Center. University of Nebraska-Lincoln*
5. *Heim, R. R. (2002). August. A Review of Twentieth-Century Drought Indices Used in the United States. American Meteorological Society. **83(8)**:1149-1165.*

6. *Keyantash, J. and Dracup, J. A. (2002). The quantification of drought: An evaluation of drought indices. Bulletin of American Meteorological Society.* ***83 (8)****: 1167-1180.*

7. *Kumar, M. N., Murthy, C. S., Sesha Sai, M. V. R. and Roy, P. S. (2012). Spatiotemporal analysis of meteorological drought variability in the Indian region using standardized precipitation index. Meteorol. Apps.* ***19****: 256–264.*

8. *Mishra, A. K. and Desai, V. R. (2005). Spatial and temporal drought analysis in the Kansabati River Basin, India. Int. J. River Basin Manage.* ***3 (1)****: 31–41.*

9. *Morid, S., Smakhtin, V. and Moghaddasi, M. (2006). Comparison of seven meteorological indices for drought monitoring in Iran. International Journal of Climatology. 26 (7):971-985.*

10. *Patel, N. R., Parida, B. R., Venus, V., Saha, S. K. and Dadhwal, V. K. (2012). Analysis of agricultural drought using vegetation temperature condition index (VTCI) from Terra/MODIS satellite data. Environ. Monitor. Assess.* ***(184)****: 7153–7163.*

11. *Rathore, M. S. (2005). State level analysis of drought policies and impacts in Rajasthan, India. Colombo, Sri Lanka: IWMI. 40p. (Working paper 93: Drought Series Paper No. 6).*

12. *Rathore, N. S. (2011). A Historical Perspective of the Development of Rain Water Harvesting Techniques in the Mewar Region, Udaipur, Rajasthan, India."International Journal of Water Resources & Arid Environments****1 (4)****: 285-294.*

13. *Rathore, N.S., 2010. A Historical Perspective of the Development of Rain Water Harvesting Techniques in the Mewar Region, Udaipur, Rajasthan, India. Mountain Region of India. Conference Proceeding; 4th International Conference on Water Resources and Arid Environments 2010, Riyad, Kingdom of Saudi Arabia, pp: 429-438.*

14. *SAARC Disaster Management Center New Delhli. (2008). Draft: Indigenous knowledge for disaster risk reduction in south Asia.*

15. *Saravi, M. M., Safdari, A. A., & Malekian, A. (2009). Intensity-Duration-Frequency and spatial analysis of droughts using the Standardized Precipitation Index. Hydrology and Earth System Sciences Discussions, 6(2) : 1347-1383.*

16. *Smakhtin, V. U. and Hughes, D. A. (2004). Review, Automated estimation and analysis of drought indices in South Asia, Working Paper 83, International Water Management Institute, Sri Lanka.*